

CHAPTER 5—DESIGN OF THE MATHEMATICS ASSESSMENT

BLUEPRINT

The mathematics framework was based on Maine’s *Learning Results*, which identifies eleven **content standards**, as shown below:

- **Numbers and number sense:** Students understand and demonstrate a sense of what numbers mean and how they are used.
- **Computation:** Students understand and demonstrate computation skills.
- **Data analysis and statistics:** Students understand and apply concepts of data analysis.
- **Probability:** Students understand and apply concepts of probability.
- **Geometry:** Students understand and apply concepts from geometry.
- **Measurement:** Students understand and demonstrate measurement skills.
- **Patterns, relations, and functions:** Students understand that mathematics is the science of patterns, relationships, and functions.
- **Algebra concepts:** Students understand and apply algebraic concepts.
- **Discrete mathematics:** Students understand and apply concepts in discrete mathematics.
- **Mathematical reasoning:** Students understand and apply concepts of mathematical reasoning.
- **Mathematical communication:** Students reflect upon and clarify their understanding of mathematical ideas and relationships.

These standards were used to create a reporting category framework for mathematics, shown below. The framework was divided into two major areas:

- **content**, which refers to the student’s knowledge and conceptual and procedural understanding of each standard, and
- **application**, which refers to a student’s use of knowledge and conceptual and procedural understanding as a basis for application through reasoning, inquiry, communication of ideas, and problem solving.

Each question in the mathematics assessment measured a content standard; in addition, each question was reported as measuring either content or application.

As shown in the table below, the goal for distribution of questions, or emphasis, across standards varies from grade to grade.

Content Standard	Grade		
	4	8	11
A. Number and Number Sense	15%	14%	10%
B. Computation	15%	11%	5%
C. Data Analysis and Statistics	12%	11%	10%
D. Probability	8%	11%	10%
E. Geometry	12%	11%	15%
F. Measurement	12%	10%	10%
G. Patterns, Relations, Functions	12%	13%	15%
H. Algebra Concepts	9%	14%	15%
I. Discrete Mathematics	5%	5%	10%

CONTENT AND APPLICATION

For students to function effectively as mathematical problem-solvers, they must be taught how to apply and communicate basic concepts and procedures as well as how to do the procedures themselves.

Content questions measure what students have been taught directly. Included in these are the basic concepts and procedural skills from all the content standards. For example, in the numbers and number sense standard

and the computation standard, conceptual and procedural knowledge includes understanding of place value in our number system; the computational algorithms as applied to whole numbers, fractions, and decimals; and the concepts of ratio, proportion, and percent. In the data analysis and statistics standard, conceptual and procedural knowledge includes the reading of charts and graphs as well as the concepts of averages (means, medians, and modes) and methods for computing them. Contextual settings used in questions measuring this category are very simple and are directly related to those used in the teaching of the concepts and procedures.

Application questions measure what the students can do with what they have been taught. Included are questions requiring students to combine the basic concepts and procedures to solve real-life and mathematical problems, to evaluate their own ideas and the ideas of others using mathematical reasoning, and to communicate their ideas using the wealth of symbolic, pictorial, graphic, and verbal representations available in mathematics.

It is important to understand that application questions also measure mastery of the basic concepts and procedures. For example, in mathematics, 20% of the questions are either constructed- or extended-response questions (see “Content Specs” on the next page), which are worth up to 4 and 8 score points respectively. In most cases, portions of these questions require the student to perform some problem solving, reasoning, and/or communicating, and so the questions are classified under applications. At the same time, however, the questions require the students to demonstrate their understanding of mathematics content. If a student does not show mastery of all aspects of a constructed- or extended-response question, or if he/she makes careless errors, the student does not earn the highest score for that question. Thus, it can be said that **all** mathematics questions in the MEA measure content; some questions go beyond that realm, however, and are classified for reporting purposes as application.

CONTENT SPECS

The MEA mathematics assessment included multiple-choice, short-answer, constructed-response, and extended-response questions. Short-answer questions, which were new in the revised MEA, required students to perform a computation or solve a simple problem. Extended-response questions in mathematics are similar to constructed-response questions except that they are more complex, requiring 10 to 20 minutes of response time. Each type of question was worth a specific number of points in the student's total mathematics score, as shown below:

Type of Question	Possible Score Points
Multiple Choice	0–1
Short Answer	0–2
Constructed Response	0–4
Extended Response	0–8

The tables below summarize the numbers and types of questions that were used in the MEA mathematics assessment for 1998–1999. The tables show the construction of the common, matrix-sampled, and pre-test portions of the assessment.

Grade 4									
Common					Matrix/Pre-test				
Session	MC	SA	CR	ER	MC	SA	CR	ER	Time (minutes)
1 (NC)	2	2	1	–	2	1	1	–	30
2 (C)	6	1	1	–	2	1	0	–	22
3 (C)	5	0	1	–	2	0	1	–	27
4 (C)	2	0	2	–	2	0	0	–	24
Total	15	3	5	–	8	2	2	–	

Grades 8 and 11									
Common					Matrix/Pre-test				
Session	MC	SA	CR	ER	MC	SA	CR	ER	Time (minutes)
1 (NC)	3	3	2	0	0	2	1	0	43
2 (C)	6	0	0	1	4	0	1	0	40
3 (C)	6	0	1	0	4	0	0	1	40
Total	15	3	3	1	8	2	2	1	

Key

- (C) = calculator use allowed
- (NC) = no calculator use allowed
- MC = multiple-choice questions
- SA = short-answer questions
- CR = constructed-response questions
- ER = extended-response questions

THE USE OF CALCULATORS IN THE MEA

The Maine educators who designed and developed the assessment test acknowledge the importance of mastering of arithmetic algorithms. At the same time, they understand that the use of calculators is a necessary and important skill in society today. Calculators can save time and error in the measurement of some higher order thinking skills and allow students to do more sophisticated and intricate problems. For these reasons, it was decided that calculators should be permitted in some parts of the MEA mathematics assessment and prohibited in others. (Students were allowed to use any calculator with which they are familiar.)

The charts on the following pages outline the total number of possible points—as reported—by learning results and item type.

MATHEMATICS
Number of Points Possible
Grade 4

Standard	Common					Matrix Per Form					Total Possible Points
	MC	SA	CR	Points	Percent	MC	SA	CR	Points	Percent	
Content	5	4	0	9	7	112	12	0	124	93	133
Application	10	2	20	32	25	16	18	60	94	75	126
Numbers and Number Sense (Standard A)	3	0	4	7	20	21	4	4	29	80	36
Computation (Standard B)	2	0	4	6	11	16	12	16	44	89	50
Data Analysis and Statistics (Standard C)	1	2	4	7	25	14	2	4	20	75	27
Probability (Standard D)	2	0	0	2	5	12	0	20	32	95	34
Geometry (Standard E)	1	0	4	5	20	16	0	4	20	80	25
Measurement (Standard F)	2	2	0	4	18	16	4	0	20	82	24
Patterns, Relations, Functions (Standard G)	1	2	4	7	20	17	6	4	27	80	34
Algebra Concepts (Standard H)	2	0	0	2	15	6	0	4	10	85	12
Discrete Mathematics (Standard I)	1	0	0	1	5	10	2	4	16	95	17

MATHEMATICS
Number of Points Possible
Grade 8

Standard	Common						Matrix Per Form						Total Possible Points
	MC	SA	CR	ER	Points	Percent	MC	SA	CR	ER	Points	Percent	
Content	15	4	0	0	19	10.5	97	22	36	8	163	89.5	182
Application	0	2	12	8	22	10.5	28	10	28	120	186	89.5	208
Numbers and Number Sense (Standard A)	2	2	4	0	8	18	15	4	4	16	39	82	47
Computation (Standard B)	2	0	0	0	2	5	15	2	0	16	33	95	35
Data Analysis and Statistics (Standard C)	2	0	0	0	2	4	18	8	8	16	50	96	52
Probability (Standard D)	1	0	0	0	1	1	16	8	24	16	64	99	65
Geometry (Standard E)	1	2	0	0	3	6	11	2	16	16	45	94	48
Measurement (Standard F)	2	0	0	8	10	25	13	2	0	16	31	75	41
Patterns, Relations, Functions (Standard G)	1	0	4	0	5	11	16	2	12	8	38	89	43
Algebra Concepts (Standard H)	2	2	4	0	8	20	14	4	0	16	34	80	42
Discrete Mathematics (Standard I)	2	0	0	0	2	9	7	0	0	8	15	91	17

MATHEMATICS
Number of Points Possible
Grade 11

Standard	Common						Matrix Per Form						Total Possible Points
	MC	SA	CR	ER	Points	Percent	MC	SA	CR	ER	Points	Percent	
Content	9	4	0	0	13	12	63	8	8	16	95	88	108
Application	6	2	12	8	28	10	62	24	56	112	254	90	282
Numbers and Number Sense (Standard A)	1	0	4	0	5	11	18	0	4	16	38	89	43
Computation (Standard B)	2	2	0	0	4	10	20	4	8	0	32	90	36
Data Analysis and Statistics (Standard C)	2	0	0	0	2	4	14	4	16	16	50	96	52
Probability (Standard D)	2	0	0	8	2	5	19	4	8	16	47	95	49
Geometry (Standard E)	2	0	0	0	10	15	12	6	4	32	54	85	64
Measurement (Standard F)	1	0	0	0	1	3	16	0	0	0	16	97	17
Patterns, Relations, Functions (Standard G)	2	0	8	0	10	20	12	4	8	16	40	80	50
Algebra Concepts (Standard H)	2	4	0	0	6	10	12	6	16	16	50	90	56
Discrete Mathematics (Standard I)	1	0	0	0	1	5	2	4	0	16	22	95	23